AHA Clinical Update

ADAPTED FROM:

2024 AHA/ACC/ACS/ASNC/ HRS/SCA/SCCT/SCMR/SVM Guideline for Perioperative Cardiovascular Management for Noncardiac Surgery

AHA Clinical Update PPTX

American Heart Association.

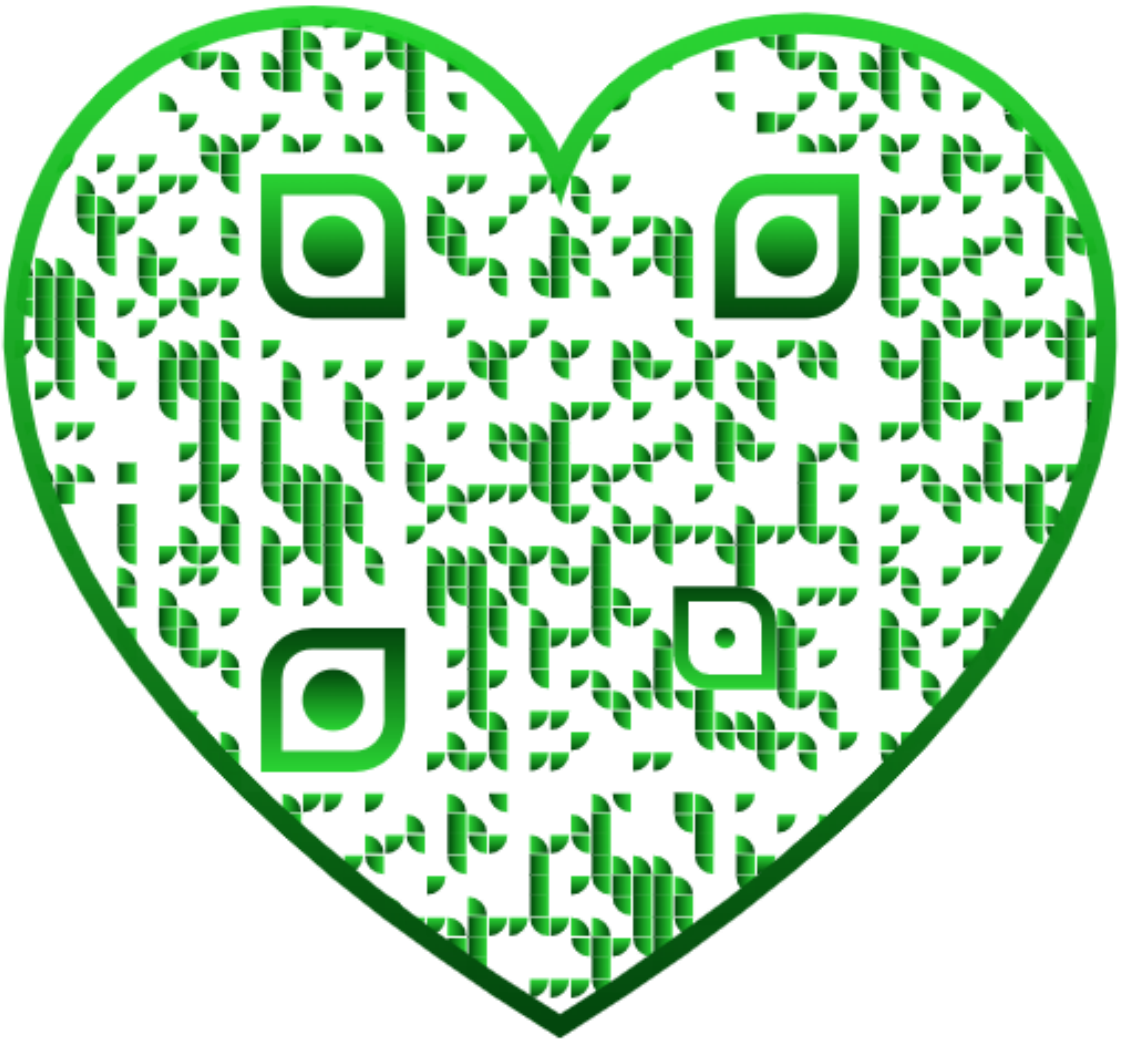

Table 1.
Applying Class of Recommendation and Level of Evidence to Clinical Strategies, Interventions, Treatments, or Diagnostic Testing in Patient Care

CLASS (STRENGTH) OF RECOMMENDATION	
CLASS 1 (STRONG)	**Benefit >>> Risk**
Suggested phrases for writing recommendations: • Is recommended • Is indicated/useful/effective/beneficial • Should be performed/administered/other • Comparative-Effectiveness Phrases†: – Treatment/strategy A is recommended/indicated in preference to treatment B – Treatment A should be chosen over treatment B	
CLASS 2a (MODERATE)	**Benefit >> Risk**
Suggested phrases for writing recommendations: • Is reasonable • Can be useful/effective/beneficial • Comparative-Effectiveness Phrases†: – Treatment/strategy A is probably recommended/indicated in preference to treatment B – It is reasonable to choose treatment A over treatment B	
CLASS 2b (Weak)	**Benefit ≥ Risk**
Suggested phrases for writing recommendations: • May/might be reasonable • May/might be considered • Usefulness/effectiveness is unknown/unclear/uncertain or not well-established	
CLASS 3: No Benefit (MODERATE)	**Benefit = Risk**
Suggested phrases for writing recommendations: • Is not recommended • Is not indicated/useful/effective/beneficial • Should not be performed/administered/other	
CLASS 3: Harm (STRONG)	**Risk > Benefit**
Suggested phrases for writing recommendations: • Potentially harmful • Causes harm • Associated with excess morbidity/mortality • Should not be performed/administered/other	

LEVEL (QUALITY) OF EVIDENCE‡	
LEVEL A	
• High-quality evidence‡ from more than 1 RCT • Meta-analyses of high-quality RCTs • One or more RCTs corroborated by high-quality registry studies	
LEVEL B-R	**(Randomized)**
• Moderate-quality evidence‡ from 1 or more RCTs • Meta-analyses of moderate-quality RCTs	
LEVEL B-NR	**(Nonrandomized)**
• Moderate-quality evidence‡ from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies • Meta-analyses of such studies	
LEVEL C-LD	**(Limited Data)**
• Randomized or nonrandomized observational or registry studies with limitations of design or execution • Meta-analyses of such studies • Physiological or mechanistic studies in human subjects	
LEVEL C-EO	**(Expert Opinion)**
• Consensus of expert opinion based on clinical experience.	

•COR and LOE are determined independently (any COR may be paired with any LOE).

•A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

•*The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

• †For comparative-effectiveness recommendation (COR 1 and 2a; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

•‡The method of assessing quality is evolving, including the application of standardized, widely-used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

•COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

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Definitions of Surgical Timing and Surgical Risk

Urgency of Surgery

RISK ↑

EMERGENCY	**Immediate threat** to life or limb without surgical intervention, <2 hours
URGENT	**Threat** to life or limb without surgical intervention, 2-24 hours
TIME-SENSITIVE	**May delay** surgery up to 3 months to complete evaluation + manage
ELECTIVE	**Complete** evaluation + manage prior to surgery

Type of Surgery

LOW RISK	ELEVATED RISK	
	INTERMEDIATE	HIGH
Endocrine	General	Vascular
Breast	ENT	Thoracic
Gynecology	Genitourinary	Transplant
Obstetrics	Orthopedic	Neurosurgery

Overall Risk (Patient + Surgical Characteristics)

MACE <1%	→ LOW RISK
MACE ≥1%	→ ELEVATED RISK

*Based on RCRI or other risk prediction tool

Abbreviations: ENT indicates ear nose throat; MACE, major adverse cardiovascular event; and RCRI, Revised Cardiac Risk Index.

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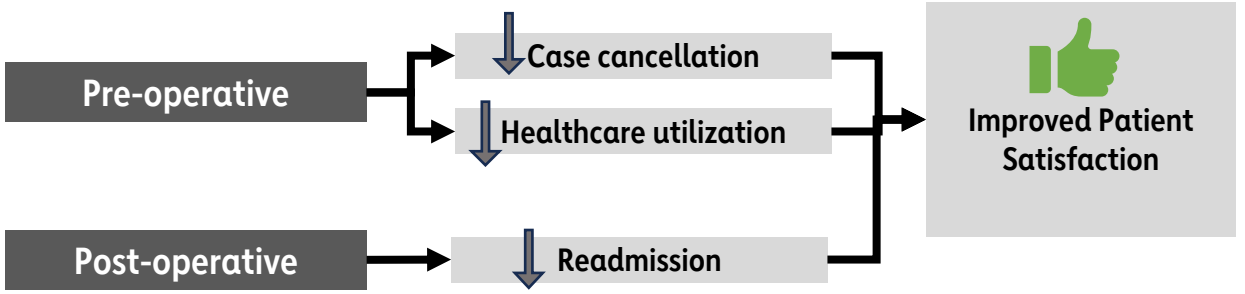
Team Based Care

Team Based Perioperative Care

Interdisciplinary Models and Pathways

- Standardize perioperative practices
- Accelerate and coordinate recovery

Telemedicine Visits



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Risk Prediction Tools

* For pts with CVD, age ≥65 years, or age ≥45 years with symptoms suggestive of CVD undergoing elevated risk NCS

COR	RECOMMENDATIONS
2a	In patients with known cardiovascular disease (CVD) being considered for NCS, a validated risk-prediction tool can be useful to estimate the risk of perioperative MACE.

Risk Calculators

OLDEST ↓ NEWEST

- Goldman Index of Cardiac Risk
- Revised Cardiac Risk Index (RCRI)
- Universal NSQIP Perioperative MI and Cardiac Arrest (MICA) Risk Calculator
- NSQIP Surgical Risk Calculator
- Surgical Outcome Risk Tool
- NSQIP Geriatric-Sensitive Perioperative Cardiac Risk Index
- AUB-HAS2 Cardiovascular Risk Index

Abbreviations: AUB indicates American University of Beirut; COR, class of recommendation; CVD, cardiovascular disease; LOE, level of evidence; MACE, major cardiovascular adverse events; NCS, non-cardiac surgery; and NSQIP, National Surgical Quality Improvement Program.

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Patient Factors: Functional Capacity and Frailty

Functional Capacity

COR	RECOMMENDATIONS
2a	In patients undergoing elevated risk NCS, structured assessment of functional capacity is reasonable to stratify risk of perioperative adverse cardiovascular events.

Walk up 2 flights of stairs? → **≥4 METS**

Duke Activity Status Index (DASI) → **>34**

Frailty

COR	RECOMMENDATIONS
2a	In all patients with perceived frailty who are undergoing elevated risk NCS, preoperative frailty assessment using a validated tool can be useful for evaluating perioperative risk and guiding management.

- *"Physiologic declines across multiple organ systems resulting in increased vulnerability to stressors"*
- Prevalence **10.7%** among community-dwelling individuals ≥65 years of age
- Frailty **2x** higher in women ♀ than men ♂
- **Validated instruments:** Physical Frailty Phenotype, Deficit Accumulation Index, FRAIL Scale, Clinical Frailty Scale, SPPB

Abbreviations: COR indicates class of recommendation; LOE, level of evidence; MET, metabolic equivalent; NCS, non-cardiac surgery; and SPPB, Short Physical Performance Battery

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Preoperative Risk Stratification: Biomarkers

BNP or NT-proBNP

COR	RECOMMENDATIONS
2a	In patients with known CVD, or age ≥65 years, or age ≥45 years with symptoms suggestive of CVD undergoing elevated-risk NCS, it is reasonable to measure **B-type natriuretic peptide (BNP) or N-terminal pro–B-type natriuretic peptide (NT-proBNP)** before surgery to supplement evaluation of perioperative risk.

Cardiac Troponin

COR	RECOMMENDATIONS
2b	In patients with known CVD, or age ≥65 years, or age ≥45 years with symptoms suggestive of CVD undergoing elevated-risk NCS, it may be reasonable to measure **cardiac troponin (cTn)** before surgery to supplement evaluation of perioperative risk.

Abbreviations: COR indicates class of recommendation; BNP, B-type natriuretic peptide; cTn, cardiac troponin; CVD, cardiovascular disease; NCS, noncardiac surgery; and NT-proBNP, N-terminal pro-B-type natriuretic peptide.

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Preoperative Cardiovascular Diagnostic Testing:
12-Lead ECG

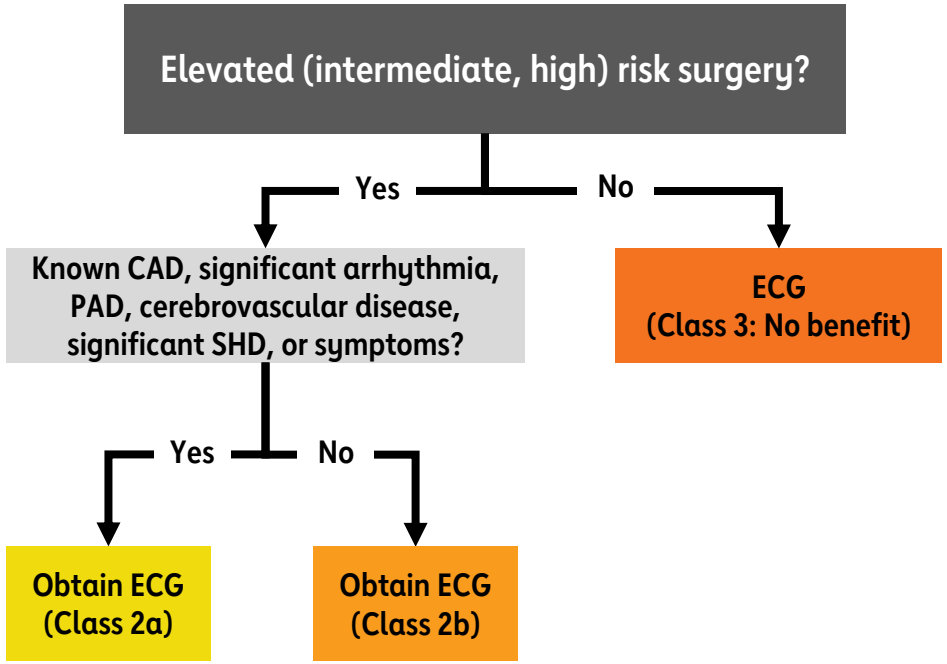
IF preoperative ECG shows new abnormalities*

↓

Obtain further evaluation to refine cardiovascular risk (Class 2a)

***Abnormalities may include:**

- ST segment elevation or depression, T wave inversions
- Left ventricular hypertrophy
- Significant pathologic Q-waves
- Mobitz type II or higher AV block
- Bundle branch block
- QT prolongation
- Atrial fibrillation



Abbreviations: CAD indicated coronary artery disease; ECG, electrocardiogram; MACE, major adverse cardiovascular events; PAD, peripheral artery disease; and SHD, structural heart disease.

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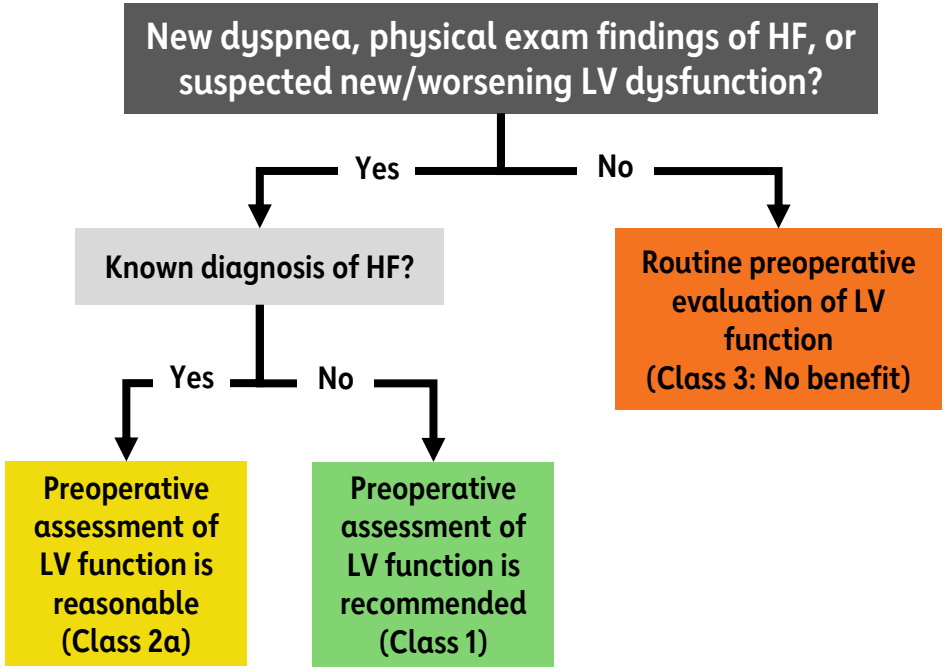
Preoperative Cardiovascular Diagnostic Testing: Assessing Ventricular Function

Right Ventricular Function

- RV dysfunction associated with adverse CV outcomes in NCS.
- Routine preoperative evaluation of RV function **is not recommended** in asymptomatic and clinically stable patients.

Left Ventricular Function


New dyspnea, physical exam findings of HF, or suspected new/worsening LV dysfunction?
Yes
No
Known diagnosis of HF?
Routine preoperative evaluation of LV function (Class 3: No benefit)
Yes
No
Preoperative assessment of LV function is reasonable (Class 2a)
Preoperative assessment of LV function is recommended (Class 1)

Abbreviations: CV indicates cardiovascular; HF, heart failure; LV, left ventricular; NCS, non-cardiac surgery; and RV indicates right ventricular.

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Preoperative Cardiovascular Diagnostic Testing: Stress Test and CPET

STRESS TEST

Low risk for perioperative CV events (<1% MACE) + Low-risk procedure + Functional capacity ≥4 METS with stable symptoms

→ Routine stress test not recommended (Class 3: No benefit)

Poor or unknown functional status (<4 METS) + Undergoing elevated risk NCS + Elevated risk perioperative CV events (≥1% MACE)

→ Consider stress test to evaluate for inducible myocardial ischemia (Class 2b)

CPET

CPET can provide additional physiologic data to inform perioperative care or guide optimization in patients with reduced functional capacity undergoing elevated risk procedures.

Modality	Contraindications*
Vasodilator pharmacologic stress imaging	VT, high grade heart block, hypotension, broncho-constrictive/-spastic disease, recent use of dipyridamole, aminophylline, or caffeine within 12 hours
Exercise stress testing	Inability to exercise
Dobutamine stress echocardiography	Critical aortic stenosis, hemodynamically significant LVOT obstruction

Abbreviations: CPET indicates cardiopulmonary exercise testing; CV, cardiovascular; LVOT, left ventricular outflow tract; MACE, major adverse cardiovascular events; MET, metabolic equivalent; NCS, non-cardiac surgery; and VT, ventricular tachycardia.

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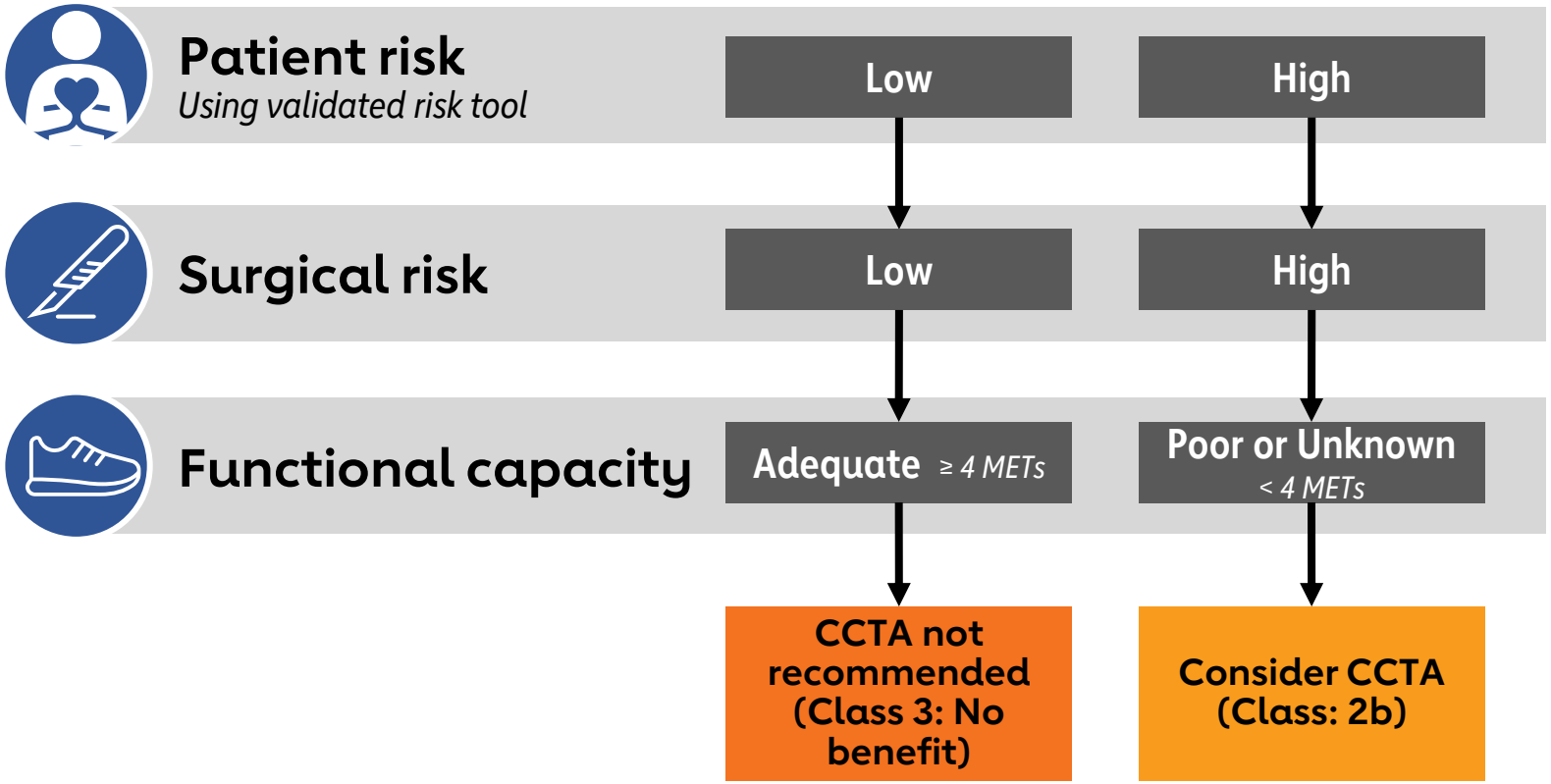
Preoperative Testing: Coronary CT Angiography



Abbreviations: CCTA indicates coronary computed tomography angiography; CT, computed tomography; and METs, metabolic equivalents.

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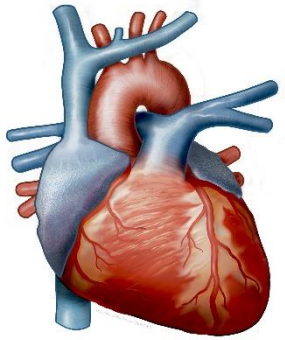
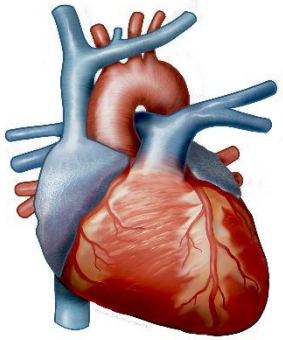
Preoperative Testing:
Invasive Coronary Angiography

Invasive Coronary Angiography	
COR	**RECOMMENDATIONS**
3: No Benefit	In patients undergoing NCS, routine preoperative ICA is not recommended to improve perioperative outcomes.



Insufficient data that routine pre-operative ICA improves early or long-term post-operative outcomes



Pre-operative ICA remains indicated for ACS, angina despite maximal medical therapy, moderate-severe ischemia, or obstructive left main disease

Abbreviations: ACS indicates acute coronary syndrome; ICA, invasive coronary angiography; and NCS, non-cardiac surgery

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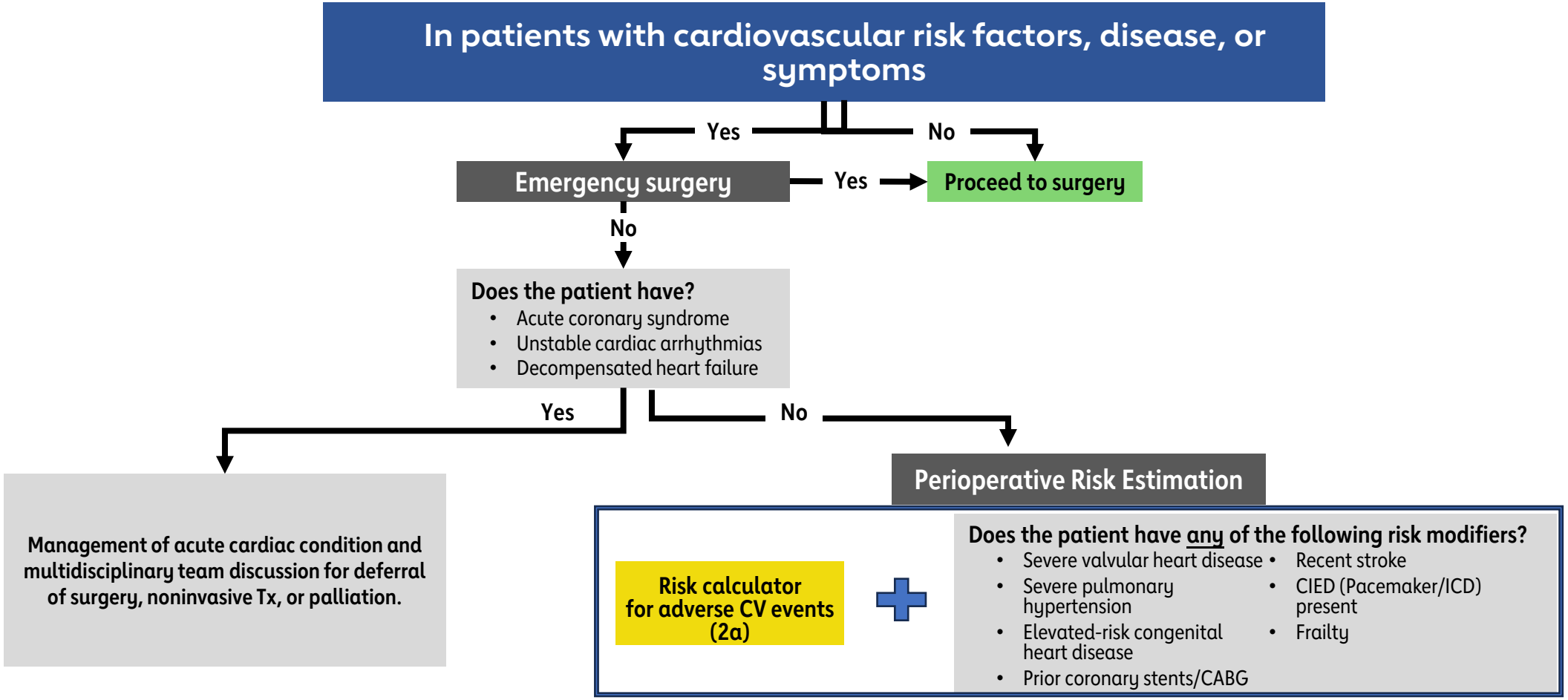
Stepwise Approach to Perioperative Cardiac Assessment in NCS


In patients with cardiovascular risk factors, disease, or symptoms
Yes
No
Emergency surgery
Yes
Proceed to surgery
No
Does the patient have?
• Acute coronary syndrome
• Unstable cardiac arrhythmias
• Decompensated heart failure
Yes
No
Management of acute cardiac condition and multidisciplinary team discussion for deferral of surgery, noninvasive Tx, or palliation.
Perioperative Risk Estimation
Risk calculator for adverse CV events (2a)
Does the patient have any of the following risk modifiers?
• Severe valvular heart disease
• Severe pulmonary hypertension
• Elevated-risk congenital heart disease
• Prior coronary stents/CABG
• Recent stroke
• CIED (Pacemaker/ICD) present
• Frailty

Continued

Abbreviations: CABG indicates coronary artery bypass grafting; CIED, cardiovascular implantable electronic devices; CV, cardiovascular; ICD, implantable cardioverter-defibrillator; NCS, noncardiac surgery; and Tx, treatment.

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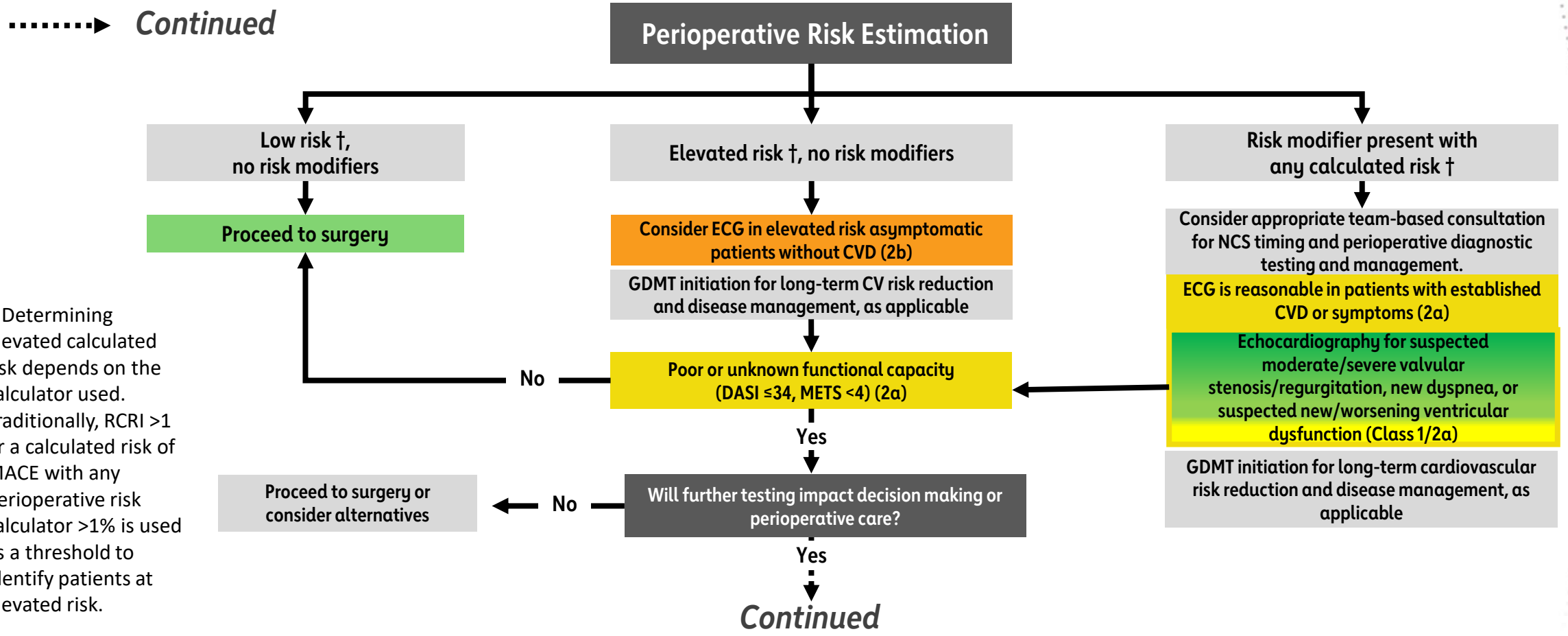
Stepwise Approach to Perioperative Cardiac Assessment in NCS - continued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Perioperative Risk Estimation
Low risk †, no risk modifiers
Elevated risk †, no risk modifiers
Risk modifier present with any calculated risk †
Proceed to surgery
Consider ECG in elevated risk asymptomatic patients without CVD (2b)
GDMT initiation for long-term CV risk reduction and disease management, as applicable
Consider appropriate team-based consultation for NCS timing and perioperative diagnostic testing and management.
ECG is reasonable in patients with established CVD or symptoms (2a)
Echocardiography for suspected moderate/severe valvular stenosis/regurgitation, new dyspnea, or suspected new/worsening ventricular dysfunction (Class 1/2a)
No
Poor or unknown functional capacity (DASI ≤34, METS <4) (2a)
Yes
GDMT initiation for long-term cardiovascular risk reduction and disease management, as applicable
Proceed to surgery or consider alternatives
No
Will further testing impact decision making or perioperative care?
Yes
Continued

† Determining elevated calculated risk depends on the calculator used. Traditionally, RCRI >1 or a calculated risk of MACE with any perioperative risk calculator >1% is used as a threshold to identify patients at elevated risk.

Abbreviations: ECG indicates electrocardiography; CV, cardiovascular; CVD, cardiovascular disease; DASI, Duke activity status index; GDMT, guideline directed medical therapy; METS, metabolic equivalents; and NCS, noncardiac surgery

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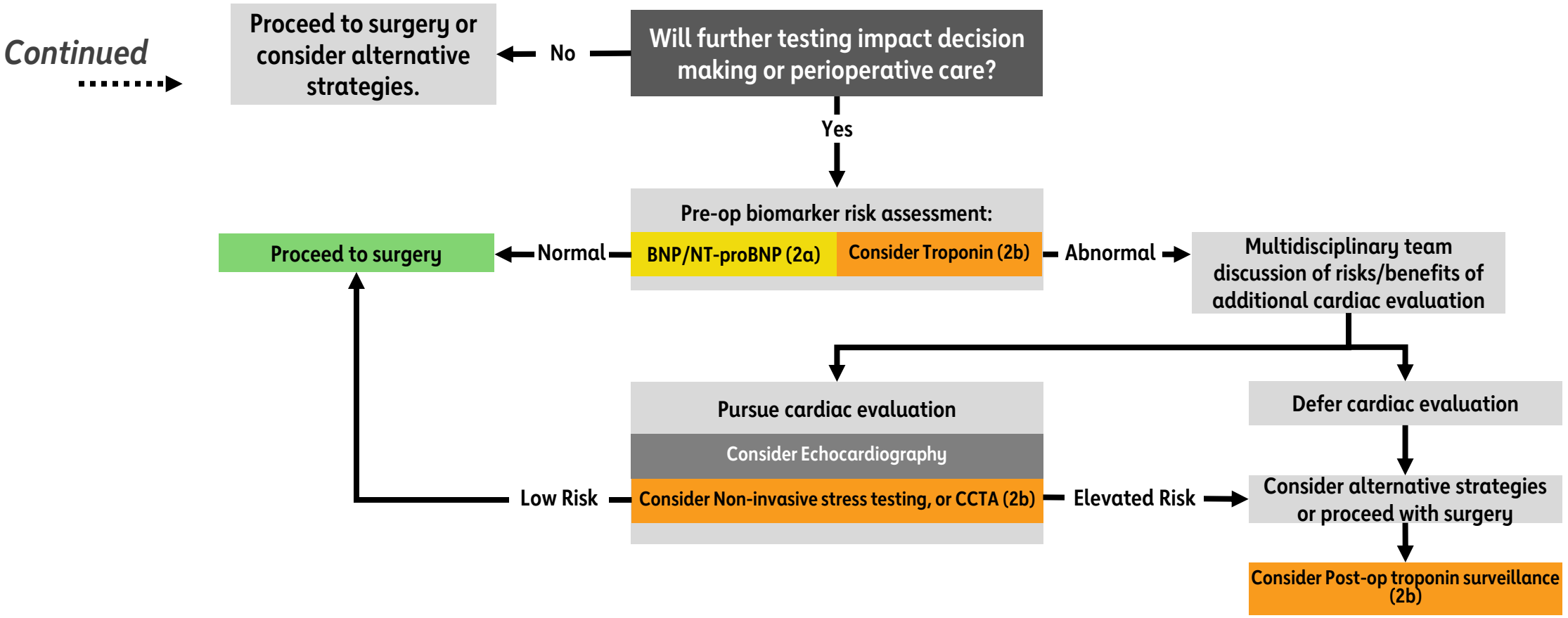
Stepwise Approach to Perioperative Cardiac Assessment in NCS -continued



Abbreviations: BNP indicates b-type natriuretic peptide; CCTA, coronary computed tomography angiography; NCS, noncardiac surgery; and NT-proBNP, N-terminal pro b-type natriuretic peptide.

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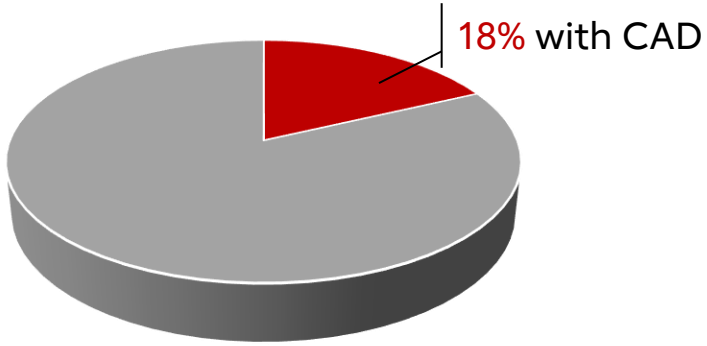
Perioperative Management:
Coronary Revascularization

In patients undergoing non-cardiac surgery:



History of MI:

3.5x increased risk of perioperative MACE

Prior coronary stent within 2 years:

2x increased risk of perioperative MACE

Revascularization Prior to Elective NCS	
COR	**RECOMMENDATIONS**
1	For patients with ACS, pre-operative revascularization is recommended .
2a	For patients with chronic coronary disease and significant left main stenosis (>50%), consider pre-operative revascularization.
3: No Benefit	For patients with non-left main CAD, revascularization not recommended.

Abbreviations: ACS indicates acute coronary syndrome; CAD, coronary artery disease; MACE, major adverse cardiovascular events; MI, myocardial infarction; and NCS, non-cardiac surgery.

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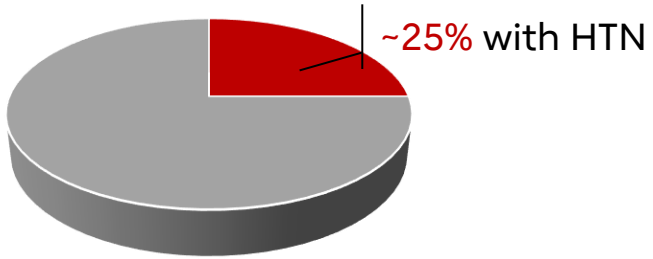
Perioperative Management: Hypertension

In patients undergoing non-cardiac surgery:



Preoperative Management

COR	RECOMMENDATIONS
2a	In most patients with HTN, it is reasonable to continue medical therapy for HTN throughout the preoperative period.
2b	In most patients undergoing elective elevated risk surgery who have cardiovascular risk factors and recent history of poorly controlled HTN (SBP ≥180 mm Hg or DBP ≥110 mmHg), consider deferring surgery.

Intraoperative Management

COR	RECOMMENDATIONS
1	In patients undergoing NCS, maintaining intraoperative MAP ≥60-65 mmHg or SBP ≥90 mmHg is recommended.

Postoperative Management

COR	RECOMMENDATIONS
1	In patients undergoing NCS, treatment of hypotension MAP <60-65 or SBP <90 mmHg in the post-operative period is recommended.
1	In patients with HTN undergoing NCS, it is recommended that preoperative antihypertensive medications be restarted as soon as clinically reasonable.

Abbreviations: DBP indicates diastolic blood pressure; HTN, hypertension; MAP, mean arterial pressure; NCS, non-cardiac surgery; and SBP, systolic blood pressure

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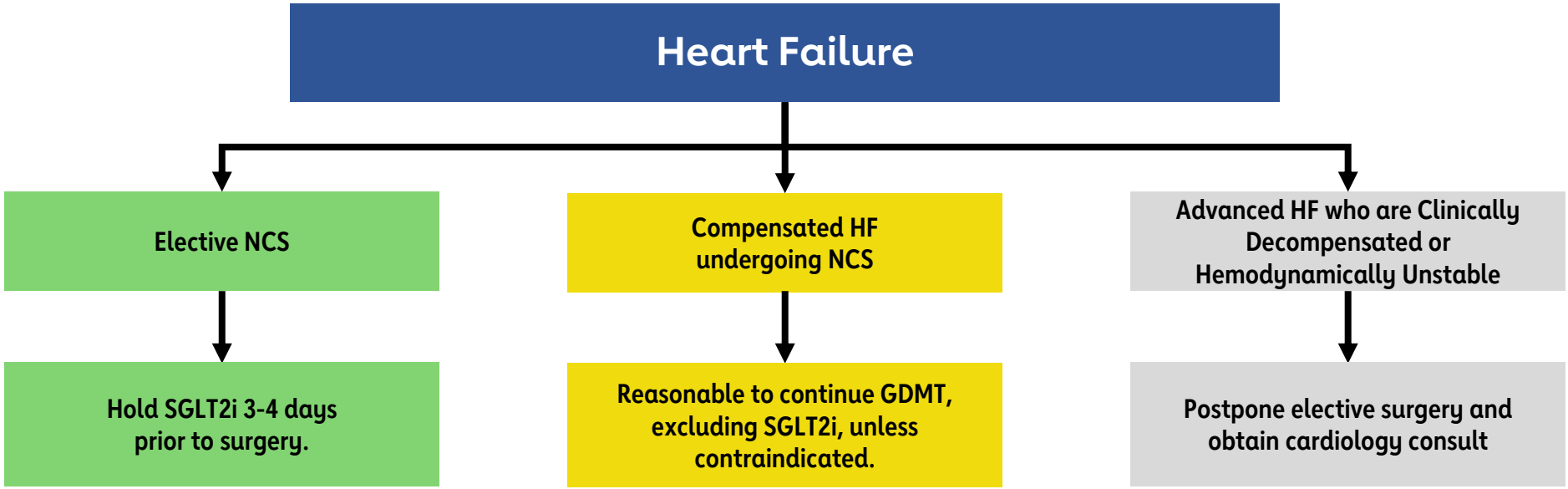
Perioperative Management:
Heart Failure


Heart Failure
Elective NCS
Hold SGLT2i 3-4 days prior to surgery.
Compensated HF undergoing NCS
Reasonable to continue GDMT, excluding SGLT2i, unless contraindicated.
Advanced HF who are Clinically Decompensated or Hemodynamically Unstable
Postpone elective surgery and obtain cardiology consult

Abbreviations: GDMT indicates guideline-directed medical therapy; ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; ARNi, angiotensin receptor-neprilysin inhibitor; BB, beta blocker; MRA, mineralocorticoid receptor antagonist; and SGLT2i, sodium-glucose cotransporter-2 inhibitor.

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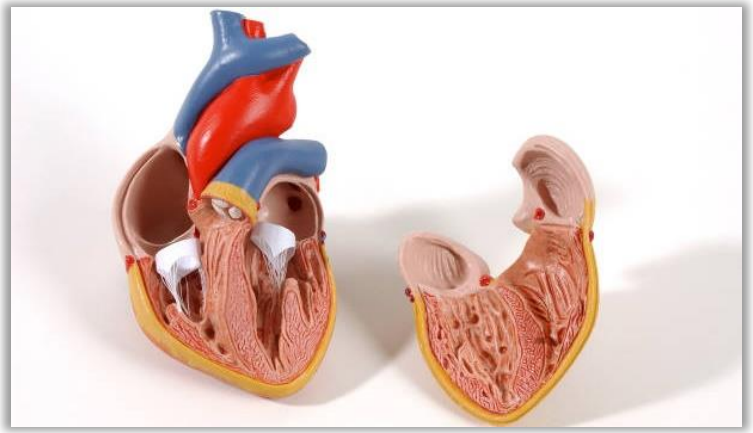
Perioperative Management:
Hypertrophic Cardiomyopathy

Management Considerations:

1. Continue beta-blockers and/or non-dihydropyridine calcium channel blockers without interruption.
2. Avoid hypovolemia and reduced preload
3. Avoid hypotension and reduced afterload

COR	RECOMMENDATIONS
3: Harm	In patients undergoing NCS, factors that aggravate or trigger dynamic outflow obstructions are harmful and should be avoided to reduce the risk of hemodynamic instability.



If hypotension develops:

1. Prioritize intravenous fluid administration
2. Use alpha-agonists instead of than beta-agonists
3. Consider intraoperative echocardiography to evaluate LVOT obstruction.
4. Beta-blockade may be necessary to reduce LV myocardial contractility and relieve LVOT obstruction

Abbreviations: LVOT indicates left ventricular outflow tract; LV, left ventricle; HCM, hypertrophic cardiomyopathy; and NCS, noncardiac surgery.

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Perioperative Management:
Pulmonary Hypertension

COR	RECOMMENDATIONS
1	In patients receiving stable doses of targeted medical therapies* for pulmonary arterial hypertension undergoing NCS, it is recommended to continue these agents to reduce risk for the development of perioperative MACE.
2a	In patients with severe† pulmonary hypertension undergoing elevated risk NCS, referral to or consultation with a specialized PH center that can support risk assessment, optimization, and post-operative management (with consideration of intensive care after NCS) is reasonable to reduce perioperative cardiopulmonary complications.
2a	In patients with severe† PH undergoing elevated risk NCS, invasive hemodynamic monitoring is reasonable to guide intraoperative and postoperative care.
2b	In patients with precapillary PH undergoing elevated NCS, perioperative administration of short-acting inhaled pulmonary vasodilators may be reasonable to reduce elevated right ventricular afterload and prevent acute decompensated right HF.

*See section 6.3.2 for specific medical therapies
† See section 6.3.2 for the definition of severe PH

Abbreviations: HF indicates heart failure; MACE, major adverse cardiac event; NCS, noncardiac surgery; and PH, pulmonary hypertension.

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Perioperative Management:
Adult Congenital Heart Disease

		In patients with intermediate to elevated risk CHD lesions preoperative consultation with an ACHD specialist is recommended (Class 1)	
	Low Risk	**Intermediate Risk**	**High Risk**
Anatomy	• In patients with isolated small CHD lesions • In patients with CHD repaired lesion with no residual shunt • In patients with bicuspid aortic valve disease and aortopathy	• Unrepaired moderate-large shunts • Repaired CHD with moderate to large residual shunt • Obstructive left sided lesions • Obstructive right sided lesion • Ebstein anomaly • Anomalous coronary artery arising from the pulmonary artery • Anomalous aortic origin of a coronary artery from the opposite sinus	• Single ventricle patients (palliated or status post Fontan procedure) • Unrepaired or palliated cyanotic CHD • Double outlet right ventricle • Pulmonary atresia • Truncus arteriosus • TGA • Interrupted aortic arch
Functional/ Hemodynamic Status	• NYHA Class I functional status, normal exercise capacity • No chamber enlargement on imaging • No residual shunt • No PAH • No arrhythmias	• NYHA class II- IV functional status • Limited exercise capacity • Presence of residual shunt • Presence of PAH • Presence of cardiac chamber enlargement • Significant valvular dysfunction • Arrhythmias requiring treatment • Presence of HF	• NYHA class II- IV functional status • Limited exercise capacity • Significant valvular dysfunction (more than mild in severity) • Arrhythmias requiring treatment. • Presence of PAH • Presence of HF

Abbreviations: ACHD indicates adult congenital heart disease; CHD, congenital heart disease; HF, heart failure; NYHA, New York Heart Association; PAH, pulmonary arterial hypertension; TGA, transposition of the great vessels

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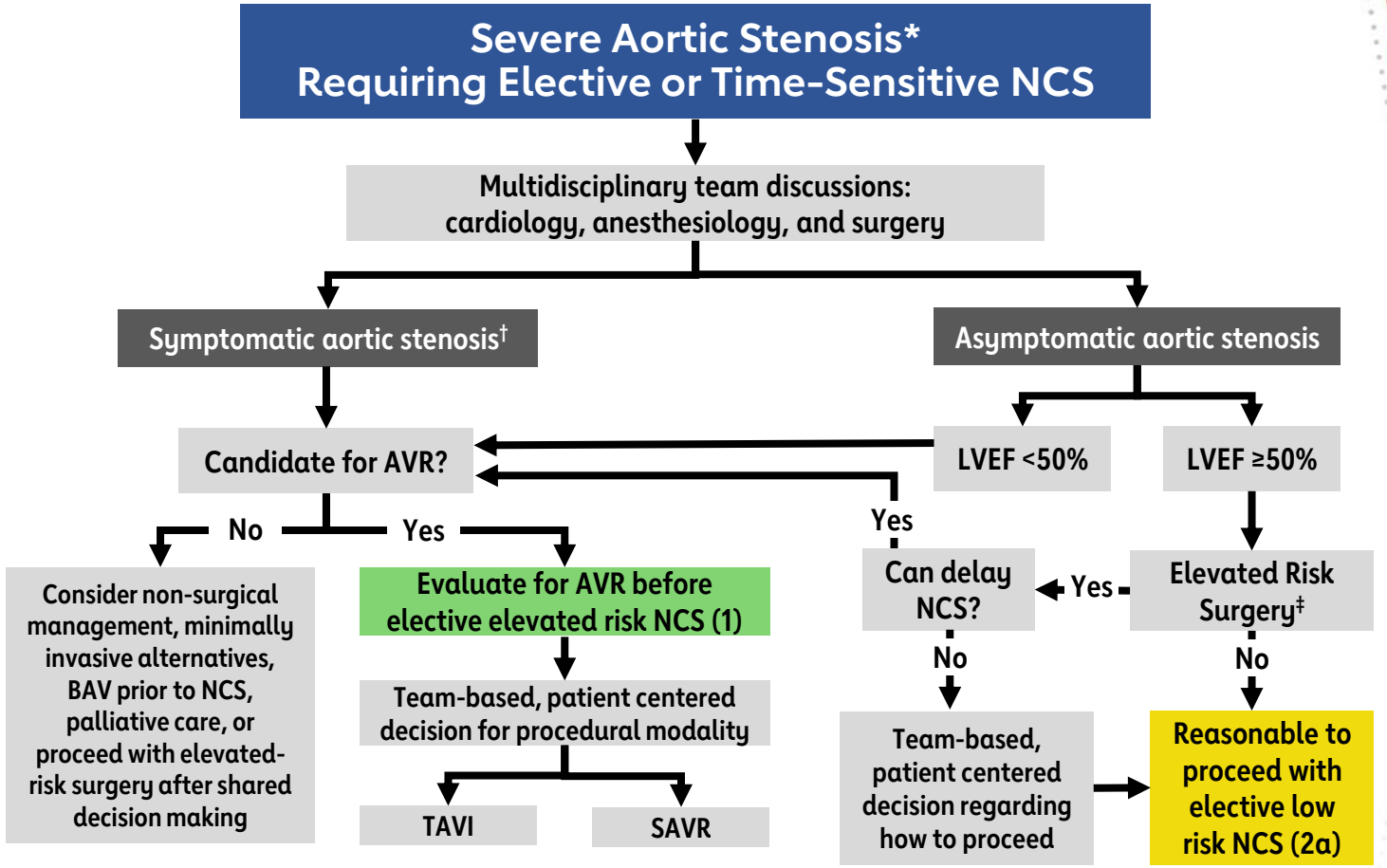
Valvular Heart Disease in NCS: Aortic Stenosis

COR	RECOMMENDATIONS
1	In patients with severe AS should be evaluated for the need for aortic valve intervention prior to elective NCS to reduce perioperative risk.
1	In patients with suspected moderate or severe AS who are undergoing elevated risk NCS, preoperative echocardiography is recommended prior to elective NCS.
2a	In asymptomatic patients with moderate or severe AS and normal LV systolic function as assessed by echocardiography within the past year, it is reasonable to proceed with elective low risk NCS.


Severe Aortic Stenosis*
Requiring Elective or Time-Sensitive NCS
Multidisciplinary team discussions:
cardiology, anesthesiology, and surgery
Symptomatic aortic stenosis†
Asymptomatic aortic stenosis
Candidate for AVR?
LVEF <50%
LVEF ≥50%
No
Yes
Yes
Consider non-surgical management, minimally invasive alternatives, BAV prior to NCS, palliative care, or proceed with elevated-risk surgery after shared decision making
Evaluate for AVR before elective elevated risk NCS (1)
Team-based, patient centered decision for procedural modality
TAVI
SAVR
Can delay NCS?
Yes
Elevated Risk Surgery‡
No
No
Team-based, patient centered decision regarding how to proceed
Reasonable to proceed with elective low risk NCS (2a)

Abbreviations: AS indicates aortic stenosis; AVR, aortic valve replacement; BAV, balloon aortic valvuloplasty; LV, left ventricular; LVEF, left ventricular ejection fraction; NCS, non-cardiac surgery; SAVR, surgical aortic valve replacement and TAVR, transcatheter aortic valve replacement.

American Heart Association.

Valvular Heart Disease in NCS: Mitral Stenosis

Mitral Valve Stenosis + Noncardiac Surgery	
COR	**RECOMMENDATIONS**
1	In patients with severe MS should be evaluated for the need for MV intervention prior to elective NCS.
2a	In patients with severe MS who cannot undergo MV intervention prior to NCS, perioperative invasive hemodynamic monitoring is reasonable to guide management.
2b	In patients with severe MS who cannot undergo MV intervention prior to NCS, perioperative heart-rate control may be considered to prolong diastolic filling time and decrease perioperative cardiovascular complications.

Abbreviations: MS indicates mitral stenosis; MV, mitral valve; and NYHA, New York Heart Association.

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Valvular Heart Disease in NCS:
Chronic Aortic and Mitral Regurgitation

Mitral Valve Stenosis + Noncardiac Surgery	
COR	**RECOMMENDATIONS**
1	In patients with suspected moderate or severe valvular regurgitation, preoperative echocardiography is recommended prior to elective NCS.
1	In patients with valvular heart disease who meet indications for valvular intervention based on clinical presentation and severity of regurgitation, the need for valvular intervention should be considered before elective elevated risk NCS.
2a	In asymptomatic patients with moderate or severe MR, normal left ventricular systolic function, and estimated PA systolic pressure <50 mm Hg, it is reasonable to perform elective NCS.
2a	In asymptomatic patients with moderate or severe aortic regurgitation and normal left ventricular systolic function, it is reasonable to perform elective NCS.

Abbreviations: MR indicates mitral regurgitation; NCS, noncardiac surgery; PA, pulmonary artery.

American Heart Association.

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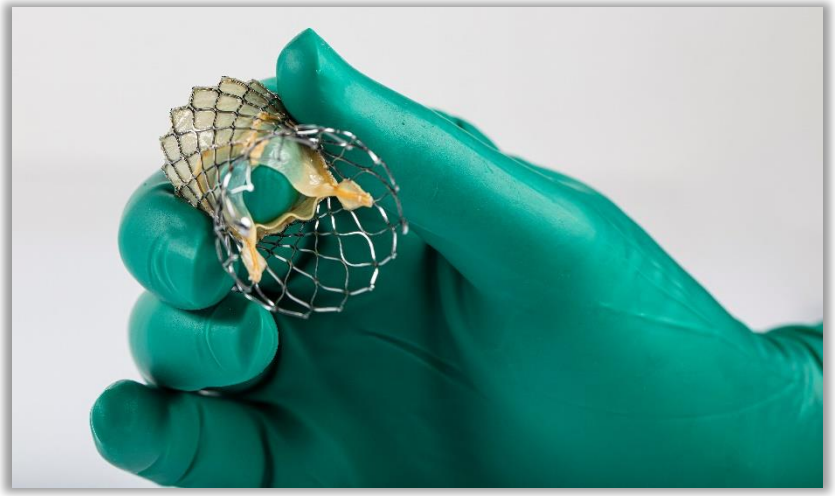
Valvular Heart Disease in NCS:
Patients with TAVI and TEER

Transcatheter Aortic Valve Implantation

COR	RECOMMENDATIONS
2a	For patients who undergo transcatheter aortic valve implantation (TAVI), it is reasonable to perform NCS early after successful TAVI as clinically indicated.



Mitral Transcatheter Valve Edge-to-Edge Repair

COR	RECOMMENDATIONS
2a	For patients who undergo MV TEER, it is reasonable to perform NCS after the successful MV intervention as clinically indicated.

Abbreviations: MV indicates mitral valve; NCS, noncardiac surgery; TAVI indicates transcatheter aortic valve implant; and TEER, transcatheter edge-to-edge repair.

American Heart Association.

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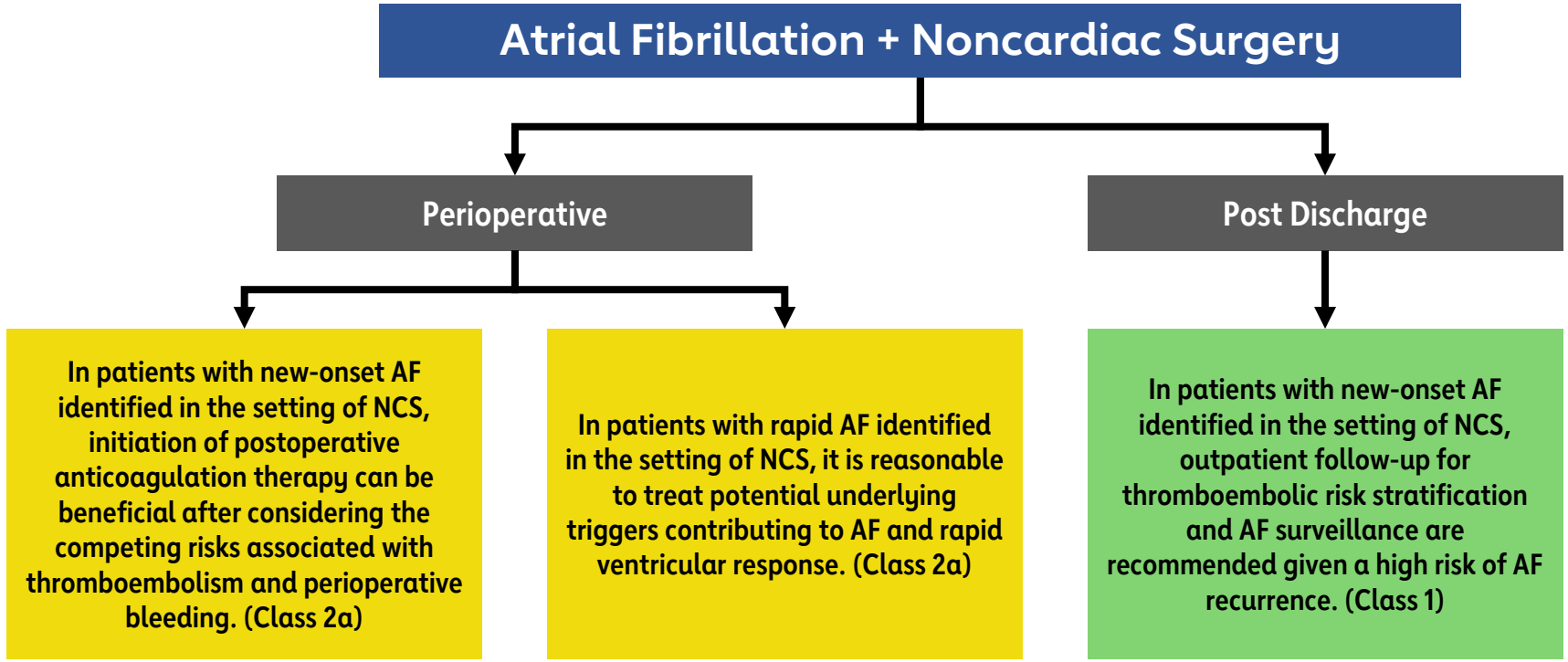
Atrial Fibrillation and NCS


Atrial Fibrillation + Noncardiac Surgery
Perioperative
Post Discharge
In patients with new-onset AF identified in the setting of NCS, initiation of postoperative anticoagulation therapy can be beneficial after considering the competing risks associated with thromboembolism and perioperative bleeding. (Class 2a)
In patients with rapid AF identified in the setting of NCS, it is reasonable to treat potential underlying triggers contributing to AF and rapid ventricular response. (Class 2a)
In patients with new-onset AF identified in the setting of NCS, outpatient follow-up for thromboembolic risk stratification and AF surveillance are recommended given a high risk of AF recurrence. (Class 1)

Abbreviations: AF indicates atrial fibrillation; and NCS, noncardiac surgery.

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Cardiovascular Implantable Electronic Devices and NCS

COR	RECOMMENDATIONS
1	In patients with CIEDs having elective NCS should have a management plan developed before surgery if EMI is anticipated, including identification of the type of CIED, manufacturer, and model.
1	Patients who are PM-dependent having surgeries above umbilicus with anticipated EMI should have the PM reprogrammed or place magnet on the generator to provide an asynchronous mode to avoid pacing inhibition.
1	PM-dependent patients with a transvenous ICD undergoing surgery above the umbilicus with anticipated EMI should have the device reprogrammed; If not PM-dependent, then either reprogramming or magnet placed on the generator can be used to inhibit tachytherapies or inappropriate shocks.
1	Patients who have a PM or ICD reprogrammed to asynchronous pacing or have a tachytherapies programmed off before surgery should have device functioning restored in the post-operative setting before to hospital discharge.

Abbreviations: CIED indicates cardiovascular implantable electronic device EMI, electromagnetic interference; ICD, implantable cardioverter-defibrillator; NCS, non-cardiac surgery; and PM, pacemaker.

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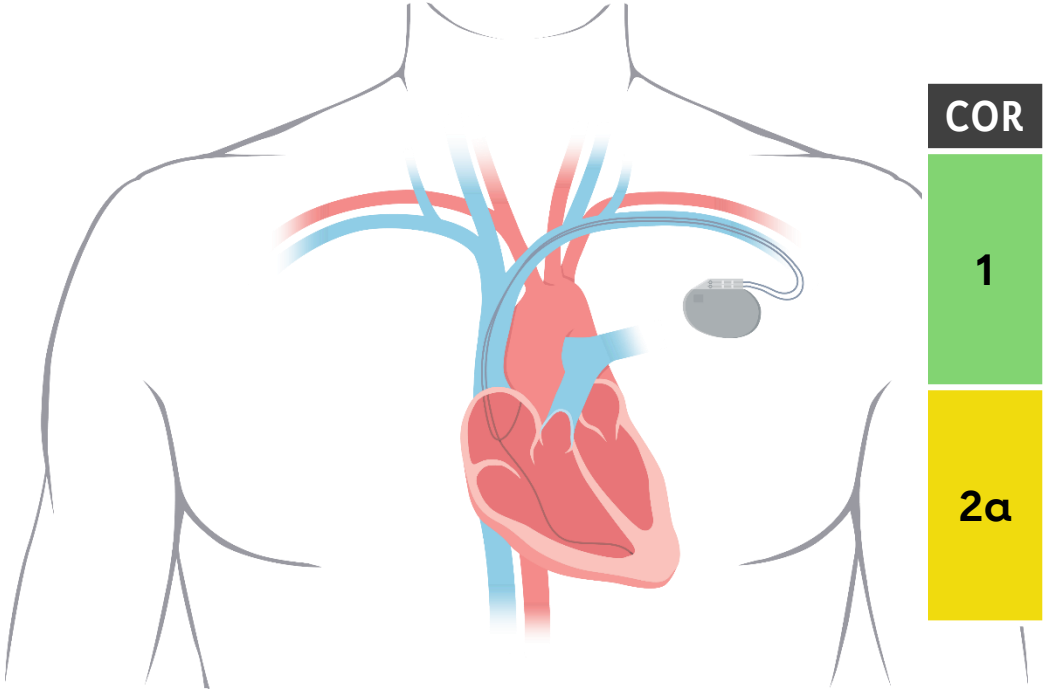
Cardiovascular Implantable Electronic Devices



COR	RECOMMENDATIONS
1	Patients with leadless PMs who are pacemaker-dependent having surgeries with anticipated EMI above the umbilicus should have their PMs reprogrammed to an asynchronous mode.
2a	For patients with subcutaneous ICD having noncardiac or nonthoracic surgery with anticipated EMI above the groin, it is reasonable to reprogram the device or use a magnet to temporarily disable tachytherapies.

Abbreviations: ICD indicates implantable cardioverter defibrillator; EMI, electromagnetic interference; NCS, non-cardiac surgery; and PM, pacemaker.

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Previous Stroke or Transient Ischemic Attack

COR	RECOMMENDATIONS
2a	In patients with a history of stroke or TIA, reasonable to delay elective NCS for at least 3 months after the most recent event to reduce the incidence of recurrent stroke and/or MACE.

Abbreviations: MACE indicates major adverse cardiovascular event; NCS, non-cardiac surgery; and TIA, transient ischemic attack.

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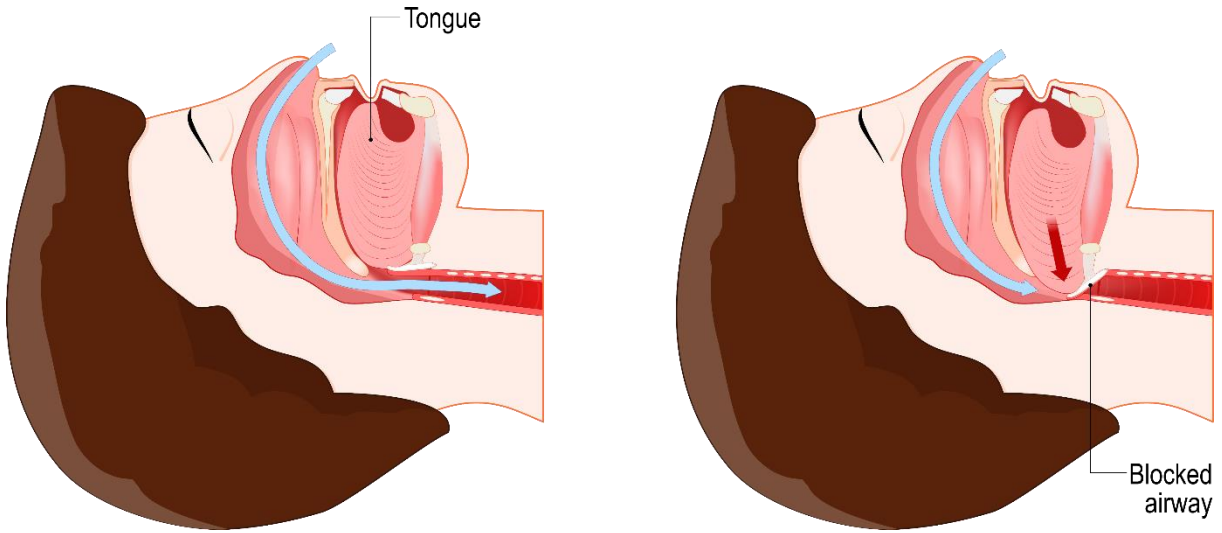
Obstructive Sleep Apnea



Normal Breathing **Sleep Apnea**

COR	RECOMMENDATIONS
2a	In patients scheduled for NCS, screening for OSA using validated questionnaires is reasonable to assess the risk of perioperative complications.

Abbreviations: NCS indicates noncardiac surgery; and OSA, obstructive sleep apnea.

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Perioperative Medical Therapy:

Statins, Renin-Angiotensin-Aldosterone System Inhibitors, and Alpha-2 Agonists

	COR	RECOMMENDATIONS
Statins	1	In patients scheduled for NCS, continue statins in those already on one to reduce MACE risk.
	1	In statin naïve patients, who meet criteria* and are scheduled for NCS, recommend initiation of statin perioperatively with the intention of long-term use.

*based on ASCVD history or 10-year risk assessment

	COR	RECOMMENDATIONS
RAASi	2b	In patients, with controlled blood pressure undergoing elevated risk NCS, on chronic RAASi holding 24 hours prior to surgery may be beneficial to limit intraoperative hypotension.
	2a	In patients on chronic RAASi for HFrEF, reasonable to continue perioperatively.

	COR	RECOMMENDATIONS
Alpha-2 Agonists	3: No Benefit	Initiation of low-dose clonidine perioperatively is **not** recommended to reduce cardiovascular risk in patients undergoing NCS.

Abbreviations: HFrEF indicates heart failure with reduced ejection fraction; MACE, major adverse cardiovascular events; NCS, non-cardiac surgery; and RAASi, renin-angiotensin-aldosterone system inhibitors.

American Heart Association.

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Perioperative Medical Therapy:
Antiplatelet Therapy and Timing of NCS in Patients with CAD

Antiplatelet Therapy	
COR	**RECOMMENDATIONS**
1	In patients with CAD undergoing elective NCS, perioperative management of antiplatelet therapy and timing of surgery should be determined by a multidisciplinary team with shared decision making to weigh the risks of bleeding, thrombosis, and consequences of delayed surgery.

Perioperative Antiplatelet Management Post PCI	
COR	**RECOMMENDATIONS**
1	In patients with prior PCI undergoing NCS, it is recommended to continue low-dose aspirin* (75-100 mg), if possible, to reduce the risk of cardiac events.
1	In patients with CAD who require time sensitive NCS within 30 days of PCI with BMS or <3 months of PCI with DES, DAPT should be continued unless the risk of bleeding outweighs the benefit of the prevention of stent thrombosis.

*P2Y12 inhibitors monotherapy may be considered if surgical bleeding risks are acceptable or if aspirin is not tolerated

Abbreviations: BMS indicates bare-metal stent; CAD, coronary artery disease; DES, drug-eluting stent; DAPT, dual antiplatelet therapy; NCS, non-cardiac surgery; and PCI, percutaneous coronary intervention.

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Perioperative Medical Therapy:
Antiplatelet Therapy and Timing of NCS in Patients with CAD

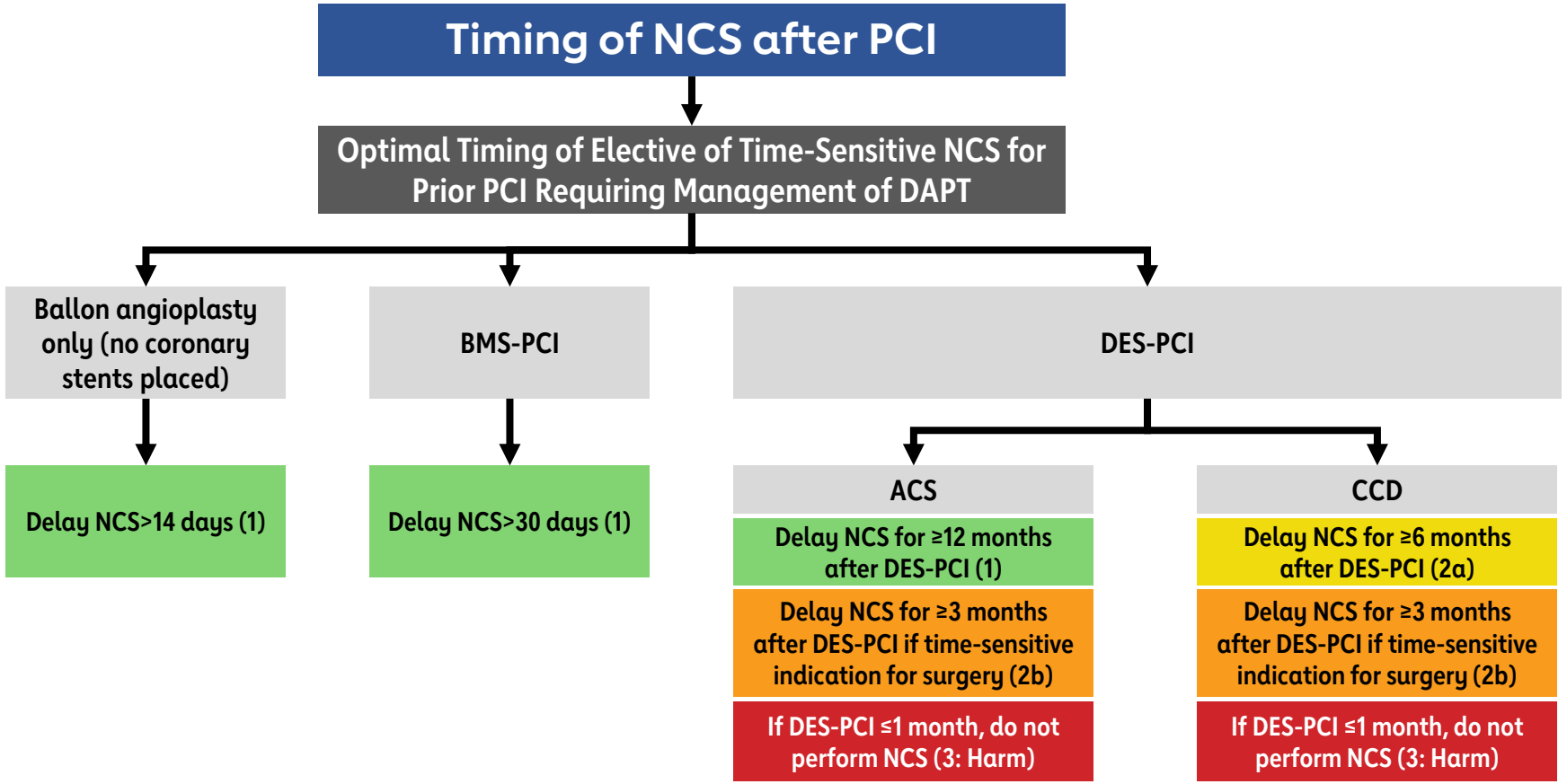
Perioperative Antiplatelet Management Post PCI - *continued*	
COR	**RECOMMENDATIONS**
1	In patients with prior PCI in whom OAC monotherapy must be discontinued prior to NCS, ASA should be substituted when feasible in the perioperative period until the OAC can be safely re-initiated.
2a	In select patients after PCI who have a high thrombotic risk, perioperative bridging with intravenous antiplatelet therapy may be considered <6 months after DES or <30 days after BMS if NCS cannot be deferred.

Perioperative Antiplatelet Management in Patients without Prior PCI	
COR	**RECOMMENDATIONS**
2b	In patients with CCD without prior PCI undergoing elective NCS, it may be reasonable to continue ASA in selected patients when the risk of cardiac events outweighs the risk of bleeding.
3: No Benefit	In patients with CAD but without prior PCI undergoing elective non-cardiac non-carotid surgery, routine ASA is not beneficial.

Abbreviations: ASA indicates aspirin; BMS, bare-metal stent; CAD, coronary artery disease; CCD, chronic coronary disease; DES, drug-eluting stent; NCS, noncardiac surgery; OAC, oral anticoagulation; and PCI, percutaneous coronary intervention.

American Heart Association.

Perioperative Medical Therapy:
Antiplatelet Therapy and Timing of NCS in Patients with CAD


Timing of NCS after PCI
Optimal Timing of Elective of Time-Sensitive NCS for Prior PCI Requiring Management of DAPT
Ballon angioplasty only (no coronary stents placed)
BMS-PCI
DES-PCI
Delay NCS>14 days (1)
Delay NCS>30 days (1)
ACS
CCD
Delay NCS for ≥12 months after DES-PCI (1)
Delay NCS for ≥6 months after DES-PCI (2a)
Delay NCS for ≥3 months after DES-PCI if time-sensitive indication for surgery (2b)
Delay NCS for ≥3 months after DES-PCI if time-sensitive indication for surgery (2b)
If DES-PCI ≤1 month, do not perform NCS (3: Harm)
If DES-PCI ≤1 month, do not perform NCS (3: Harm)

Abbreviations: ACS indicates acute coronary syndrome; BMS; bare-metal stent; CCD; chronic coronary syndrome; DAPT, dual antiplatelet therapy; DES, drug-eluting stent; NCS, non-cardiac surgery; and PCI, percutaneous coronary intervention.

American Heart Association.

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Perioperative Medical Therapy: Oral Anticoagulants

OAC Management

COR	RECOMMENDATIONS
1	In patients with CVD receiving OAC who require elective NCS, multidisciplinary team-based approach to duration of interruption* is recommended to balance competing risks of thromboembolism and bleeding.

OAC Bridging

COR	RECOMMENDATIONS
2a	In patients with CVD and high thrombotic risk* undergoing NCS where interruption of VKA is required, preoperative bridging with parenteral heparin can be effective for thromboembolic risk reduction.
3: Harm	In most patients with CVD who are planned for an elective NCS where OAC interruption is warranted, routine bridging is **not** recommended due to increased bleeding risk.

OAC Resumption

COR	RECOMMENDATIONS
2a	In patients with preoperative OAC interruption, resumption of OAC is reasonable after hemostasis is achieved.

*See **tables** with full details in the guidelines.

Abbreviations: CVD indicates cardiovascular disease; NCS, non-cardiac surgery; OAC, oral anticoagulation; and VKA vitamin K antagonist.

American Heart Association.

Perioperative Medical Therapy: Beta-Blockers

COR	RECOMMENDATIONS
1	In patients on stable BB doses undergoing NCS, BB should be continued through the perioperative period as clinically appropriate.
2b	In patients planned for elective NCS with a new indication for beta blockade, BB may be initiated well in advance before surgery (optimally >7 days) to allow for the assessments of tolerability and drug titration, as needed.
3: Harm	In patients undergoing NCS who have no immediate BB need, BB should **not** be initiated on the day of surgery due to increased risk for postoperative mortality.

Abbreviations: BB indicates beta blockers; and NCS, non-cardiac surgery.

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Perioperative Medical Therapy: Blood Glucose

COR	RECOMMENDATIONS
2a	In patients with or at risk for DM who are scheduled for elective NCS, preoperative HgbA1C testing is reasonable if not performed within 3 months.
1	In patients scheduled for NCS, SGLT-2i should be discontinued 3-4 days* before surgery to reduce the risk of perioperative metabolic acidosis.
2a	In patients with DM or impaired glucose tolerance, continuation of metformin during the perioperative period is reasonable to maintain glycemic control.

*Canagliflozin, dapagliflozin and empagliflozin should be stopped ≥3 days and ertugliflozin ≥4 days prior to scheduled surgery

Abbreviations: DM indicates diabetes mellitus; Hgb, hemoglobin; NCS, noncardiac surgery; SGLT2-I, sodium-glucose co-transporter 2 inhibitors.

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Choice of Anesthetic Agent and Technique

COR	RECOMMENDATIONS
2a	In patients undergoing NCS, use of a volatile-based anesthetic or total intravenous anesthesia is reasonable * for general anesthesia.
2a	In patients undergoing NCS, when neuraxial anesthesia is available, either neuraxial or general anesthesia is reasonable*.

*: No apparent difference in cardiovascular events, such as myocardial injury or infarction

Abbreviations: NCS indicates noncardiac surgery.

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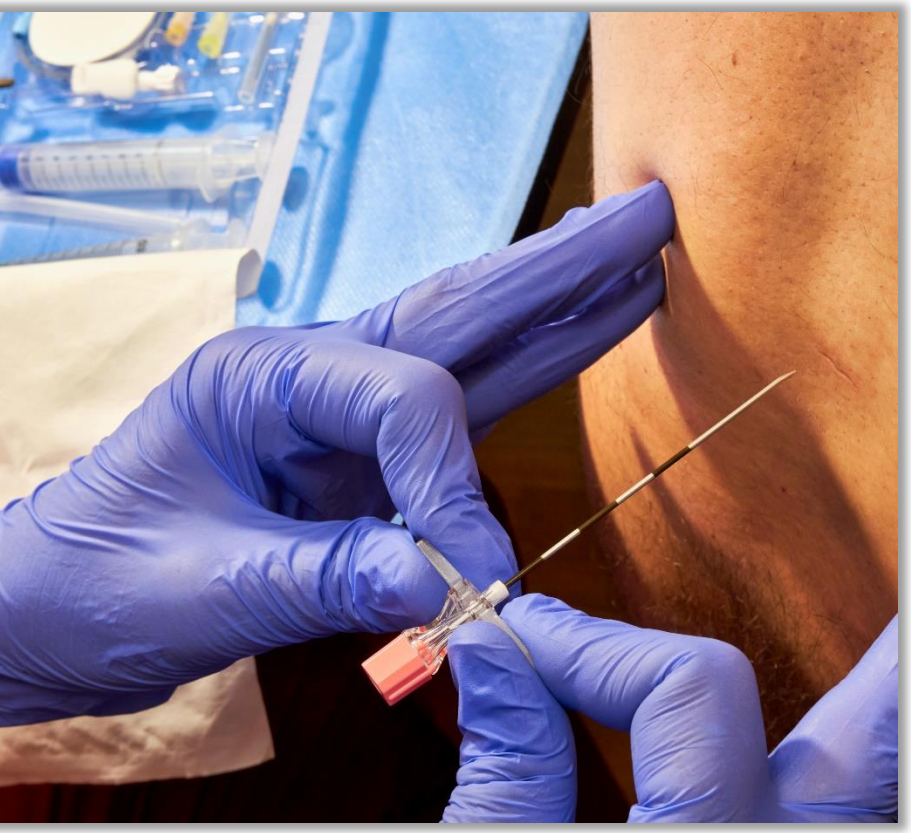
Perioperative Pain Management



Epidural analgesia

COR	RECOMMENDATIONS
2a	***Postoperatively*** in patients undergoing major abdominal surgery*

Preferred site: **thoracic**

Reasonable to reduce perioperative cardiac events

COR	RECOMMENDATIONS
2b	***Preoperatively*** in patients with hip fracture

Preferred site: **lumbar**

May be considered to reduce preoperative cardiac events

*: e.g., gastrectomy, distal esophagectomy, Whipple procedure, and open abdominal procedures

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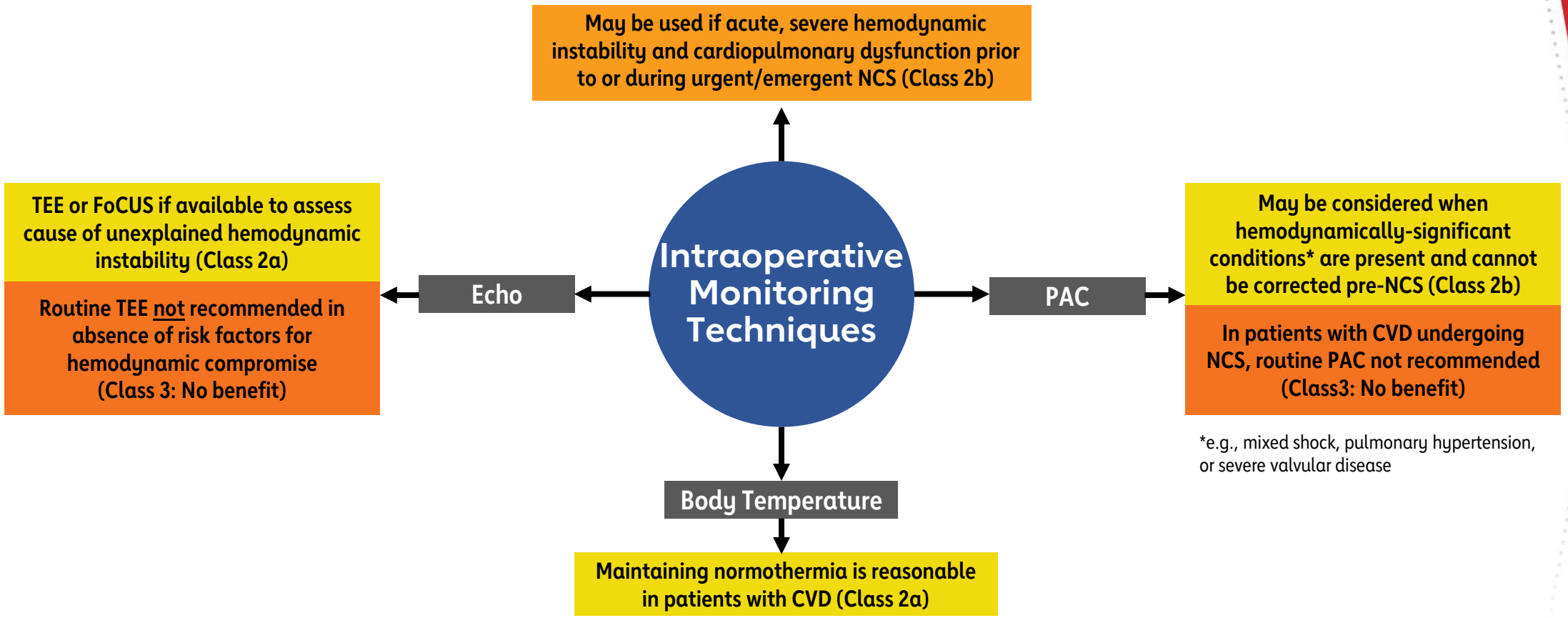
Intraoperative Monitoring Techniques


May be used if acute, severe hemodynamic instability and cardiopulmonary dysfunction prior to or during urgent/emergent NCS (Class 2b)
TEE or FoCUS if available to assess cause of unexplained hemodynamic instability (Class 2a)
Routine TEE not recommended in absence of risk factors for hemodynamic compromise (Class 3: No benefit)
Echo
Intraoperative Monitoring Techniques
PAC
May be considered when hemodynamically-significant conditions* are present and cannot be corrected pre-NCS (Class 2b)
In patients with CVD undergoing NCS, routine PAC not recommended (Class3: No benefit)
*e.g., mixed shock, pulmonary hypertension, or severe valvular disease
Body Temperature
Maintaining normothermia is reasonable in patients with CVD (Class 2a)

Abbreviations: CVD indicates cardiovascular disease; FoCUS, focused cardiac ultrasound; NCS, noncardiac surgery; PAC, pulmonary artery catheterization; TEE, transesophageal echocardiography; and tMCS, temporary mechanical circulatory support.

Perioperative Anemia Management

Key background: Perioperative anemia and bleeding are modifiable risk factors for postoperative morbidity and mortality

COR	RECOMMENDATIONS
2a	In patients undergoing NCS with expected blood loss, tranexamic acid* is reasonable to reduce intraoperative blood loss, blood transfusions, and incident anemia.
2a	In patients with iron deficiency anemia undergoing elective NCS, preoperative iron therapy (either oral or intravenous) is reasonable to increase hemoglobin and reduce blood transfusions.

*: An antifibrinolytic; has been shown to be safe even in high-risk patients with history of venous thromboembolism, prior myocardial infarction, and prior ischemic stroke

Abbreviations: NCS indicates noncardiac surgery.

American Heart Association.

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Myocardial Injury After Noncardiac Surgery (MINS)

MINS Surveillance

COR	RECOMMENDATIONS
2b	May be reasonable to measure cTn at 24 & 48 hours after elevated risk NCS if: • Known CVD • Symptoms of CVD • Age ≥65 years with CV risk factors (Class 2b)
3: No Benefit	Routine perioperative cTn screening not recommended in low risk NCS without signs and sx of MI.

MINS Diagnosis

- cTn* >99th percentile of URL ***with rise-and-fall pattern***
- Presumed ischemic origin
- 12-lead ECG without STE
- No evidence of MI (4th Universal Definition)

*: Conventional 4th generation or high-sensitivity assay

MINS Management

COR	RECOMMENDATIONS
2a	Outpatient follow-up is reasonable for further evaluation and optimization of CV risk factors
2b	Antithrombotic therapy may be considered to reduce CV events

Abbreviations: cTn indicates cardiac troponin; CV, cardiovascular; CVD, cardiovascular disease; ECG, electrocardiogram; MI, myocardial infarction; NCS, noncardiac surgery; STE, ST-segment elevation; sx, symptoms; URL, upper reference limit.

American Heart Association.

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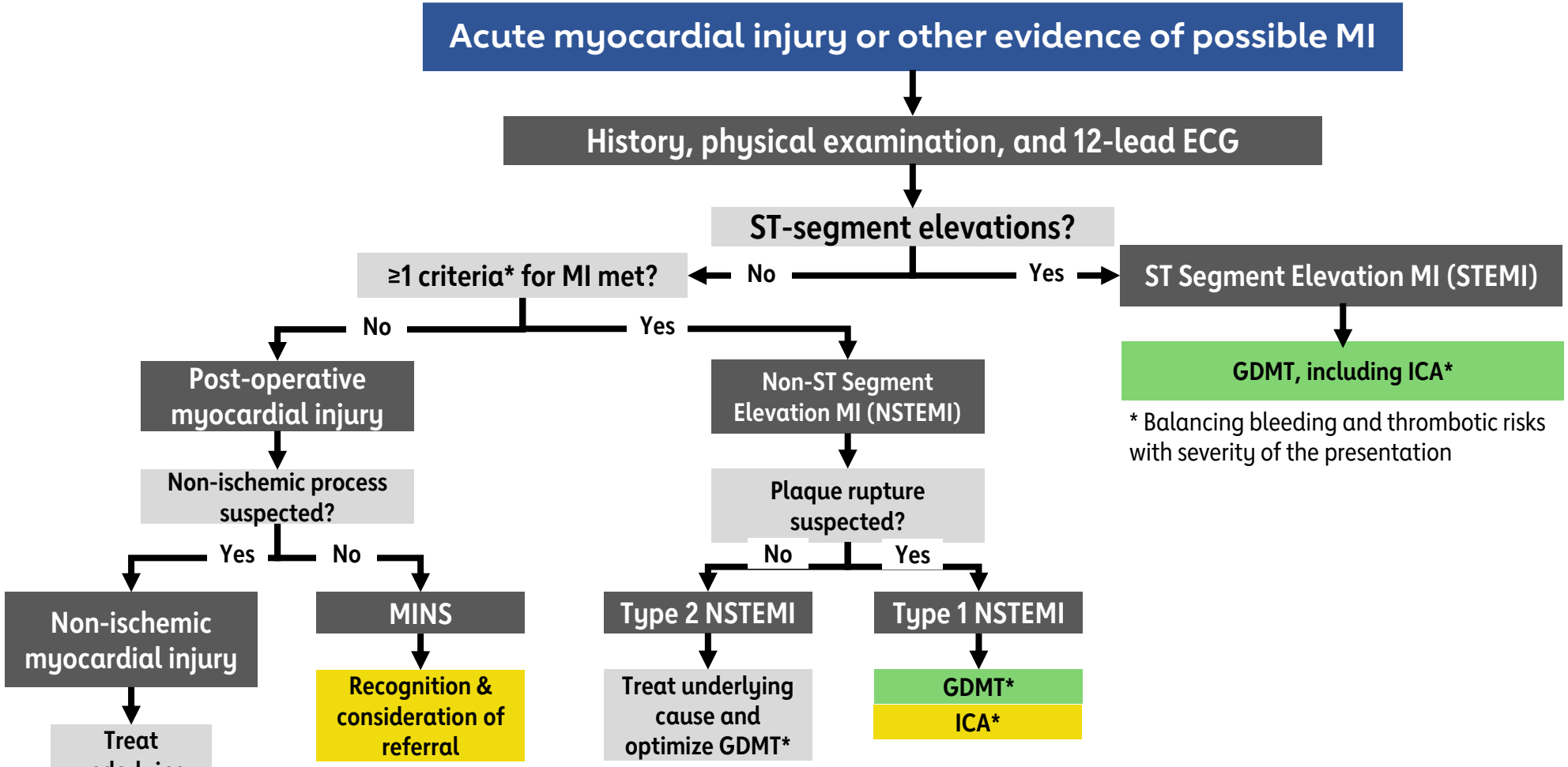
Management of Perioperative NSTEMI/STEMI



Abbreviations: ECG indicates electrocardiogram; GDMT, guideline-directed medical therapy; ICA, invasive coronary angiography; MI, myocardial infarction; and MINS, myocardial injury after noncardiac surgery.

American Heart Association.

Considerations for Special Populations:
Kidney and Liver Transplantation

Prevalence of risk factors and cardiovascular disease

Targeted pre-operative screening associated with similar outcomes compared to routine screening

Refer to "**Emerging Evidence on Coronary Heart Disease Screening in Kidney and Liver Transplantation Candidates: A Scientific Statement From the American Heart Association (2022)**" for further guidance

American Heart Association.

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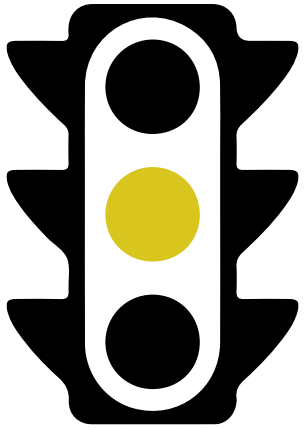
Cost Value Considerations: Biomarkers

Pre-Operative
NT-proBNP and BNP
and **Cardiac Troponin**

≠

1) Improved Patient Outcomes
2) Impact Healthcare Costs



Use of pre-operative biomarkers is of
uncertain value

**eliminating routine testing may avoid cascade of subsequent diagnostic testing*

Abbreviations: BNP indicates brain natriuretic peptide; NT-proBNP, N-terminal prohormone of brain natriuretic peptide.

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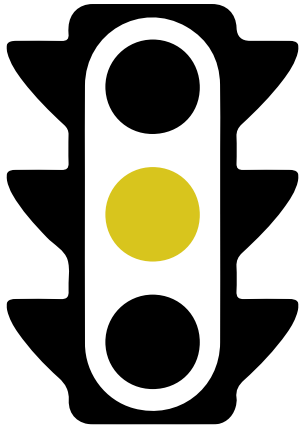
Cost Value Considerations: 12-Lead ECG

Pre-Operative
12-Lead ECG
**beyond risk factors identified in H&P*

≠

1) Improved Post-Operative Death
2) Ability to Predict MI



Use of pre-operative 12-Lead ECG is of
uncertain value

**eliminating routine testing may avoid cascade of subsequent diagnostic testing*

Abbreviations: ECG, electrocardiogram; H&P, history & physical; MI, myocardial infarction.

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Cost Value Considerations: CCTA & Stress Testing

CCTA

Associated with:

1. More coronary angiography
2. Greater healthcare costs

**compared to functional stress testing*

Echo Stress Test

Associated with:

1. Fewer clinic and emergency room visits
2. Less coronary angiography
3. Lower healthcare costs
4. No difference in composite of death, MI, unplanned revascularization, and chest pain hospitalization

**compared to exercise ECG stress testing*

PROMISE Trial

A randomized comparison of anatomic versus functional diagnostic testing strategies in symptomatic patients with suspected coronary artery disease

- *Notably **did not** include patients undergoing evaluation prior to **noncardiac surgery***
- ***USE CAUTION WHEN EXTRAPOLATING FINDINGS TO NONCARDIAC SURGERY***

Abbreviations: CCTA indicates coronary computed tomography angiography; ECG, electrocardiogram; and MI, myocardial infarction.

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Evidence Gaps and Future Research Direction

*Complete list available in Section 12 of the 2024 AHA/ACC/ACS/ASNC/HRS/SCA/SCCT/SCMR/SVM Guideline for Perioperative Cardiovascular Management for Noncardiac Surgery

Care Delivery & Risk Assessment

- Impact of multidisciplinary care models on perioperative testing – namely remote visits/telemedicine on pre-operative assessment
- Lack of evidence to support use of one perioperative risk index over another

Perioperative Management

- Approach to perioperative blood pressure assessment, thresholds, and measurement frequency
- Perioperative management of new-onset atrial fibrillation – including rate vs rhythm control and optimal surveillance
- Impact of coronary revascularization in stable patients
- Optimal timing delay of NCS after stroke

Perioperative Evaluation & Medical Therapy

- Data lacking to support pre-operative assessment of LV function
- Further need to define efficacy and safety of shorter DAPT duration
- Elucidating perioperative role of the angiotensin receptor/neprilysin inhibitor, sacubitril/valsartan
- Perioperative care of patients with DM – including glucose monitoring and management post-operatively

Intraoperative Management

- Effectiveness of routine intraoperative TEE
- Routine use of mechanical circulatory support in patients at high risk of cardiogenic shock
- Utility of pulmonary artery catheters during noncardiac surgery

Abbreviations: DAPT indicates dual anti-platelet therapy; LV, left ventricular; NCS, noncardiac surgery; and TTE, transesophageal echocardiogram.

Acknowledgments

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